

# **Magnetics Conference 2013**

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# Presentations

**Thursday, February 7th**

## **[The Rare-Earth Supply-Chain Challenge: Light at the End Of the Tunnel? 1](#)**

This presentation will provide a comprehensive, objective update on the recent dynamics in the global rare-earth sector, examining how those dynamics have directly affected the supply chain for rare-earth-based permanent magnets. We will analyze the latest rare-earth news from China concerning production and export quotas, the current status of relevant World Trade Organization disputes, consolidation of the industry within China and what all of this could mean for the downstream supply chain. We will also review the status of potential new sources of rare-earth elements outside of China. We will compare the projected future supply of magnet-related rare-earth elements to the forecasted demand for them, with a view to determining what might be in store for the permanent-magnet industry in the years to come.

*Dr. Gareth P. Hatch, Founding Principal – Technology Metals Research, LLC*

## **[Off Shore Sourcing vs In-Country Manufacturing of Magnetics: Is Magnetic Mfg. Returning to USA for Real? 34](#)**

As it is said, what goes round comes around. Could that happen to US Manufacturing that has gone through exodus of outsourcing off-shore? Given the current scenario and the trend that already has begun, don't be surprised if the trend accelerates and returning to 'in-country/in-house manufacturing' becomes a reality sooner than you expect. The outsourcing offshore may not turn out to be the nirvana you might have thought it to be. For one, giving up the manufacturing edge is equivalent to giving up the competitive edge. And, its cost is immense and immeasurable. Along with the eroding tangible cost advantages of offshore outsourcing, this factor alone may be sufficient to return to the in-house magnetic manufacturing.

*Samir Kagalwala, Consultant – Power Magnetics Consultancy*

## **[Magnet FAQs 48](#)**

Each of us has questions about magnetism and magnetic materials. Here's an opportunity to hear the en a magnetic domain and a magnet particle, raw material cost and why the prices change, will there be enough raw materials, what is the size of the magnet industry, how to calculate the holding force of a magnet, what is permeance coefficient and why it matters and more.

*Steve Constantinides, Director of Technology – Arnold Magnetic Technologies Corp.*

## **[Flexible SrFeO Magnetic Sheeting and Strip Production In Vietnam 95](#)**

The elusive pursuit of the 48-inch wide sheeting roll... The process of setting up a flexible magnetic sheeting and strip factory in Vietnam has many hurdles. Attend this presentation to learn about the decision making process – whether to locate in Vietnam

vs. US vs. China vs. India. Hear about the business side constraints including the start up legal government paperwork, banking requirements, legal requirements for forming a corporation, government safety requirements, government employment practices requirements, environmental protection fees, taxation rates, export process requirements, and information technology limits. The physical production plant set up constraints will also be reviewed and include importing machinery or finding it locally, converting imported machinery, machinery safety standards, temperature control issues, raw material locally available and imported, quality control issues, technical labor, and development of technological advances.

*John Nellessen, President – ALL Magnetics, Inc.*

### **Performance and Cost Assessment for Motors Using Alternative Rare Earth-Free Magnets 112**

Nd-Fe-B magnets in many important applications are required to operate at around 180°C, which demands the inclusion of dysprosium, for which the US Department of Energy predicts a critical short and long-term supply risk. Its Advanced Research Projects Agency Energy (ARPA-E) recently launched a Rare Earth Alternatives in Critical Technologies (REACT) program, a goal of which is to develop new classes of permanent magnet materials which are rare earth-free. This presentation illustrates the cost and performance aspects of a typical hybrid electric vehicle drive motor which is redesigned replacing sintered Nd-Fe-B with the anticipated new rare earth-free magnets.

*Dr. Peter Campbell*

### **Measuring Magnetic Field Transients 126**

Low-level disturbances in a magnetic field, for example from eddy currents in a switched magnet, are extremely difficult to measure, because the primary field swamps the interesting effect. A new generation of high-resolution, ultra-fast digital fluxmeters was designed to attack exactly this type of problem. We will present the latest developments in this domain, including theory, instrumentation and applications.

*Philip Keller, Marketing & Product Management – Metrolab Technology SA*

### **Dysprosium-Free Rare-Earth Magnets 133**

Heavy rare earths have been most affected by the escalation of rare earth prices. This has driven motor manufacturers to look for lower cost alternatives that avoid heavy rare earths, especially Dysprosium (Dy) and Terbium (Tb). Bonded and hot pressed isotropic neo powders allow for lower cost magnet solutions without using Dy and Tb. Even without Dy and Tb, bonded and hot pressed magnets still exhibit excellent temperature stability up to 200°C, making them suitable for applications like the automobile, engine cooling fans and air-conditioner compressors. Various motor case studies will be shown to illustrate the technical and economic benefits of utilizing bonded or hot pressed isotropic neo magnets in the different applications.

*Dr. Jim Herchenroeder, Vice President, Engineering and Sales Manager North America  
Molycorp Magnequench*

**Ferrofluid Immersion of Permanent Magnet Machines 146**

Learn about the effects of using a magnetic liquid to improve performance in electric motors and generators. Ferrofluids are magnetically permeable liquids, which offer electromagnetic as well as thermal benefits compared to traditional air gap systems, at the expense of several key tradeoffs. The pro's and con's of the ferrofluid approach will be presented, along with design guidelines for the technique.

*Dr. Andy Judge, Ph.D., Engineering Manager – DRS Technologies*

**Surface and Size-Dependent Properties of Fe Nanoparticles 161**

Attend this presentation to hear about the physical properties of oxide-free Fe nanoparticles synthesized with diameters between 2 and 10 nm and two different surfactants. Through careful synthesis and characterization techniques, the particles were maintained in an inert atmosphere and never formed a passivating oxide layer. Both DC and AC SQUID magnetometry were used to measure the magnetic nanoparticles saturation magnetization and anisotropy as a function of size and type of ligand. Variations in the bond length, coordination, and organic-Fe interaction as a function of particle diameter and organic surfactant were also studied through X-ray absorption fine structure (XAFS) experiments. These XAFS results will be compared with those from high energy X-ray diffraction experiments analyzed using the atomic pair distribution function (aPDF) technique.

*Todd C. Monson, Technical Staff – Sandia National Laboratories*

**High Performance Bonded Magnet Products 176**

Anisotropic NdFeB powders for bonded magnets have been around for many years, but it is only recently that a combination of scale of production, new powder grades and improvements in the performance have enabled these materials to compete purely on price. Previously some feature of the design, such as smaller size or higher performance had been necessary in order to make this the material of choice. However, the continued product development now opens up a much wider range of applications and a vastly increased market size. This presentation will talk about the manufacturing processes, the properties and future direction of the Magfine product range from Aichi Steel in Japan.

*Dr. James F. Bell, Principal Consultant – MagnetoDynamics LLC*

**Technologies to Reduce Heavy Rare Earth Materials in Nd-Fe-B Sintered Magnets 189**

Due to the very limited and controlled supply of heavy rare earth materials like Dysprosium, finding alternative options to reduce heavy metals in Nd-Fe-B sintered magnets has become critical in the market today. Learn about new technologies reducing the amount of heavy rare earth materials in Nd-Fe-B. In addition, learn about the new high performance Ferrite materials available today.

*Takeshi Murata, Magnetic Materials Research Lab, NEOMAX Division, Electronics and IT Devices Company – Hitachi Metals*

**Magnetization and Morphology of Barium Hexaferrite Thick Films Deposited by Aerosol Deposition Method 198**

Attend this presentation to hear the results of deposition of barium hexaferrite (BaFe<sub>12</sub>O<sub>19</sub>) onto copper, silicon and sapphire using aerosol deposition method to form a dense thick film by accelerating submicron sized particles at room temperature to high velocity. Results of film growth greater than 40 μm thick covering an area of 75 mm<sup>2</sup> onto copper, silicon and sapphire will be presented. Learn about film properties using scanning electron microscopy, vibrating sample magnetometry and profilometry. Initial results suggest that the film is well compacted and adhered to the substrate and shows promising magnetic response toward forming a dense bulk-like material.

*Dr. Scooter D. Johnson, ASEE Postdoctoral Fellow – US Naval Research Laboratory*

**Weathering the Storm: NdFeB Magnets in a Turbulent Market 210**

For nearly three decades after the introduction of NdFeB revolutionized the way magnets were designed, manufactured and sold, the market for this technology grew exponentially. Though it was at one time a truly global enterprise, a perfect storm of business conditions caused a shift to Asia for everything from mines to magnets. Users of NdFeB enjoyed years of decreasing prices as a result. Recent events have caused serious concerns about supply disruptions and pricing instability, portending a reexamination of how and where magnets are made and used. This presentation will discuss some of these challenges, and investigate mitigation of these, converting them into competitive opportunities.

*Randy Callihan, Vice President of Technology – Thinova Magnet Company, Ltd.*

**Real-Time Imaging of Magnetic Domains in Ferromagnets 226**

The best way to determine how a ferromagnet reverses its magnetization when subjected to a reversed field is by imaging its magnetic domains. Unfortunately, most methods for performing such observations require the removal of the magnetic field prior to domain observation. Since ferromagnets are hysteretic by nature, that means the domain pattern may be changed during the field removal. NIST has developed a real-time imaging technique called the magneto-optic indicator film (MOIF) method that circumvents this problem. Attend this presentation to learn about this technique and hear examples of prior studies wherein new magnetic phenomena were discovered.

*R.D. Shull, Materials Scientist – NIST*

**RE Permanent Magnet Supply Chain in 2015 and Beyond – Are We Trading One Vulnerability for Another? 244**

By 2015 there will be significant production of rare earth raw materials for permanent magnets outside of China (> 60,000 metric tons of rare earth oxides). A key question for these non-Chinese rare earth producers is – will there be adequate downstream processing

capacity, outside of China, to consume what is produced or will this new production capacity find it's way into Chinese supply chains? China already produces > 75 percent of the world's supply of fully dense rare earth permanent magnets. Will Chinese PM market share continue towards virtual monopoly with the help of imported rare earth materials from new producers? These and other strategic questions will be addressed by this distinguished panel.

*Panelists: Dr. Jim Herchenroeder – Molycorp Magnequench  
Stan Trout – Molycorp  
Walt Benecki – Walter T. Benecki LLC  
John Ebert – Yunsheng USA*

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## **Friday, February 8th**

### **[The USMMA Perspective on the State of the Domestic Rare Earth Supply-Chain](#) 259**

The USMMA remains focused on the domestic capabilities in the magnetic materials industry. Fluctuations in rare earth prices have caused many changes in the US rare earth supply chain. This presentation will summarize the most recent events in this area. In addition, this presentation will provide an update on US Government policy in the rare earth sector, as well as provide potential outcomes of the WTO case on rare earths.

*Ed Richardson, President – USMMA*

### **[Iron Chrome Cobalt – A Lesser Known Permanent Magnet Alternative](#) 271**

Sintered ferrites are the most utilized permanent magnet materials chiefly due to their very low price. But larger physical dimensions must be utilized due to their low induction. Engineering discussions and designs continually trend to NdFeB materials due to their high energy density. But their rare-earth content also causes significant dialogue. We would like to reintroduce the attributes of a material that is superior to both; Induction three times that of ferrite, containing no rare earth elements, AND the added unique advantage of being machinable: Iron Chrome Cobalt.

*Mike Guthrie, Director of Engineering – Quadrant Magnetics*

### **[Replacing Critical Rare Earth Materials in High Energy Density Magnets](#) 276**

High energy density permanent magnets are crucial to the design of internal permanent magnet motors (IPM) for hybrid and electric vehicles and direct drive wind generators. Current motor designs use rare earth permanent magnets that easily meet the performance goals. However, the rising concerns over cost and foreign control of the current supply of rare earth resources has motivated a search for non-rare earth based permanent magnets alloys with performance metrics, which allow the design of permanent magnet motors and generators without rare earth magnets. This presentation will discuss the state of

non-rare-earth permanent magnets and efforts to both improve the current materials and find new materials.

*R. William McCallum, Materials and Engineering Physics – Ames Laboratory, USDOE*

### **Simulating the Toyota Prius Electric Motor 303**

An in-depth look will be taken at the implementation of electromagnetic Finite Element Analysis in a real world problem in order to gain insights and best practices around this type of analysis. We will look at published results of the Toyota Prius motor in conjunction with the Opera Machines Environment by Cobham Technical Services – Vector Fields Software. The differences between 2D/3D analysis and static/dynamic analysis will be explored as well as the strength and weaknesses of each.

*Robert Kaczmarek, Vice President of Sales and Marketing  
Cobham Technical Services – Vector Fields Software*

### **Nanocomposite Carbide as Alternatives to Rare-Earth Permanent Magnets 315**

Recently, we have been able to synthesize a new nanocomposite material composed of a mixture of Co<sub>2</sub>C and Co<sub>3</sub>C nanoparticles of varying size using polyol reduction chemistry. The material offers unusual magnetic properties and has the potential to become the first non-rare earth permanent magnet developed in over 40 years. This new approach to permanent magnets allows one to tune the magnetic properties of the resulting material by controlling the magnetic characteristics of the mixed phase nanoparticles, serving as building blocks of the assembled material.

*Everett E. Carpenter, Director of Nanoscience & Nanotechnology  
Virginia Commonwealth University*

### **The Effects of Air Gap Flux Density on Permanent Magnet Brushless Motor Design 325**

This presentation will compare a permanent magnet brushless motor design as the flux density of the air gap in a permanent magnet brushless motor is changed in a range of 3 KG to 9 KG. To get this range, the Br of the magnet material must be changed. This is important due to new advances in mixing magnet materials to reduce the magnet cost, which can make the magnet Br vary from the values set by the individual materials. This case study will look at the effect of the airgap flux density in two variables. One will be to keep the output torque the same and let the motor volume change and the other will be to keep the motor volume the same and let the output torque vary. The internal iron of the magnetic circuit will be kept the same for all the variations. This will result in a variation of the motor resistance so the motor efficiency will also be plotted as a function of the air gap flux density.

*Lowell Christensen, Vice President of Engineering – TruTech Specialty Motors*



## **Joint Panel: Magnetic Advancements Improving Performance in Motor Systems**

N/A

Join this panel of magnetic supply experts and developers along with motor system manufacturers and R&D professionals. The discussion will focus on the future supply and integration of rare earth and permanent magnetics in motor systems and how motor OEMs are making the most of these advancements. The magnetic professional panelists will discuss the fluctuations in rare earth prices that have caused many changes in the US rare earth supply chain, and how these changes impact the magnetics suppliers for OEMs. The motor panelists will discuss how magnetics are impacting the motors they design and what, ideally, they would like to see from magnetic systems and suppliers.

*Ed Richardson, President – USMMA*

*Peter Dent, VP Business Development – Electron Energy Corp.*

*Dan Jones, President – Incremotion Associates*

*Thomas Wu, Professor – University of Central Florida*

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